DOCUMENT RESUME

ED 388 252 IR 017 401

AUTHOR Hartzell, Karin M.
TITLE A Hypermedia Information System for Aviation.
PUB DATE 94
NOTE 7p.; In: Educational Multimedia and Hypermedia, 1994. Proceedings of ED-MEDIA 94--World Conference on Educational Multimedia and Hypermedia (Vancouver, British Columbia, Canada, June 25-30, 1994); see IR 017 359.
PUB TYPE Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Aviation Technology; Computer Assisted Instruction; *Hypermedia; Information Retrieval; Information Storage; *Information Systems; *Job Training
IDENTIFIERS Federal Aviation Administration

ABSTRACT

The Hypermedia Information System (HIS) is being developed under the auspices of the Federal Aviation Administration (FAA) Office of Aviation Medicine's (AAM) Human Factors in Aviation Maintenance (HFAM) research program. The goal of the hypermedia project is to create new tools and methods for aviation-related information storage and retrieval. The HIS can be used alone as a tool to access information, as well as integrated with training and job aiding systems. A book paradigm is maintained by the HIS reader interface, which consists of two components: a navigation component and a viewing component. A variety of access paths into and within a document are supported: the bookshelf, the outline viewer, hot links, searching, and bookmarks. Successful integration of the HIS into the following tutoring and job aiding systems has been achieved by the FAA: the Environmental Control Systems (ECS) Tutor; the Air Traffic Control Beacon Interrogator (ATCBI) Tutor; and the Performance Enhancement System. The HIS is currently undergoing transition from a proof-of-concept system to a fully functional system capable of supporting the instructional, maintenance, and safety inspection needs of the aviation industry. The next step is to increase its capabilities and to support existing and emerging documentation standards. Contains six references. (MAS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Gary H. Marks

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

A Hypermedia Information System For Aviation

KARIN M. HARTZELL
Galaxy Scientific Corporation
2310 Parklake Drive Suite 325, Atlanta, Georgia 30345
E-mail: mathcs.emory.edu!khartzel%galsci.UUCP

ED 388 252

Abstract: The Hypermedia Information System (HIS) is being developed under the auspices of the Federal Aviation Administration (FAA) Office of Aviation Medicine's (AAM) Human Factors in Aviation Maintenance (HFAM) research program. The goal of the hypermedia project is to create new tools and methods for aviation-related information storage and retrieval. The HIS is currently undergoing transition from a proof-of-concept system to a fully functional system capable of supporting the instructional, maintenance, and safety inspection needs of the aviation industry. The next step is to increase its capabilities to support existing and emerging documentation standards.

Introduction

The aviation industry manages large quantities of documentation for many purposes, including training, research, maintenance, and safety inspection. These paper or microfiche documents include maintenance manuals, federal aviation regulations, and research reports. Timely and convenient access to these documents is important, but currently it can be quite cumbersome. For example, safety inspectors and aviation maintenance technicians must carry literally stacks of documents to the flightline when they inspect or repair an aircraft. Finding the desired information in these documents is not always easy and, therefore, not always accurate. Improvements in the way aviation personnel access this information will lead to more reliable and more cost-effective aircraft maintenance.

Toward this end, the Federal Aviation Administration (FAA) Office of Aviation Medicine (AAM) Human Factors in Aviation Maintenance (HFAM) research program is studying the challenges associated with creating, accessing, and maintaining digital documentation using a Hypermedia Information System (HIS). This paper discusses the current state of the HIS, including its interface features, system design and development, and its integration into multiple tutoring and job aiding systems.

The Hypermedia Information System Features

Over the past several years, Galaxy Scientific has been using hypermedia technology to address the challenges of improving aviation information access. After surveying commercially available products, Galaxy developed its own set of tools that could be distributed to the aviation community. Initial efforts concentrated on demonstrating the feasibility of a hypermedia system for aviation. Team members designed a digital library system and implemented rudimentary tools for information storage. The bulk of the implementation effort focused on the information retrieval tools and the hypermedia reader interface.

Federal Aviation Administration research reports were used as a testbed for creating the digital library. The proof-of-concept hypermedia viewer (FAA/AAM & GSC, 1994) proved to be a flexible and powerful way for researchers to view hypermedia documents. The HIS can be used alone as a tool to access information, as well as integrated with training and job aiding systems (Johnson and Norton, 1992). Both the viewer and the library were distributed on compact disc, read-only memory (CD-ROM) to the aviation maintenance community in early 1993. As with many proof-of-concept systems, this one was geared toward a specific application area. The viewer interface was tailored to the FAA research reports, making its broad-scale applicability limited. During the last year, research has continued, with an eye toward making the tools more generic and functional.

The HIS reader interface maintains a book paradigm and consists of two distinct components: a navigation component and a viewing component. The navigation component combines the familiarity of

IR017401

BEST COPY AVAILABLE

traditional book navigation, such as a table of contents, with the power of hypermedia searching. The viewing component allows the reader[1] to read, print, and manipulate the various media that make up the library.

Navigation

A traditional paper book provides several methods for navigating such as a table of contents, an index, and simple page turning. Likewise, the HIS supports a variety of access paths into and within a document. Some readers seek specific topics of interest and demand a powerful method for browsing a complex document. For them, the hierarchical Outline Viewer and query capabilities are useful. Other readers seek quick reference to standard information. For them, Hot Links and Bookmarks provide mechanisms for quickly going to frequently referenced places in a document.

The Bookshelf. The first component of the HIS the reader encounters is the Bookshelf, as shown in **Figure 1**. The Bookshelf is a graphical depiction of the various libraries available to the reader. The reader chooses a library by selecting an icon. The Bookshelf icons can be customized for a specific application.

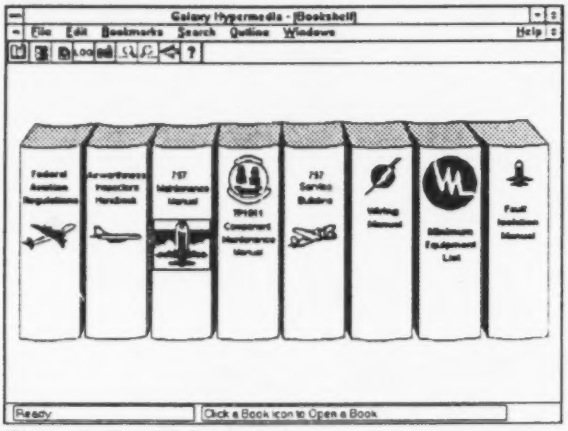

Figure 1 The HIS Bookshelf

The Outline Viewer. Once a library has been chosen, the Outline Viewer appears, displaying the complete outline for that collection of documents. The outline is similar to a Table of Contents and consists of the Topics defined for the documents in the library. A hypermedia author[2] specifies Topics within the original documents and assigns them a hierarchical order. After finding a Topic of interest, the reader selects it and the associated part of the document appears, as shown in **Figure 2**.

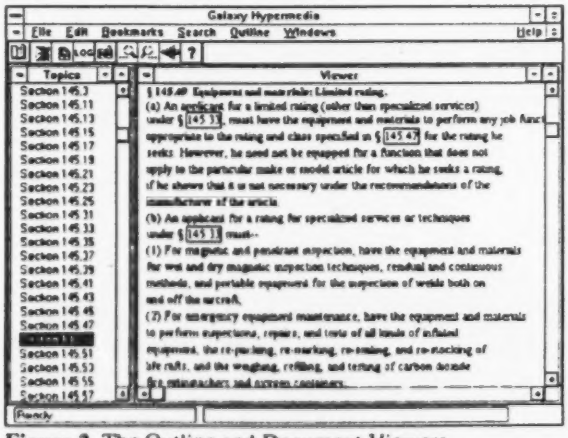

Figure 2 The Outline and Document Viewers

BEST COPY AVAILABLE

Hot Links. The HIS supports a variety of Hot Links a reader uses to navigate through the library. These include both inter- and intra-document links to text, links to graphics, Media Control Interface (MCI) supported media, definitions, and other executable programs. Hot Links are marked by a rectangular box surrounding red text (**Figure 2**).

Searching. One of the most powerful features of a hypermedia system is its ability to quickly locate specific words in large amounts of text without the reader having to scan each line of text. A reader performs a search by typing a query, as shown in **Figure 3**. The HIS then rapidly searches all documents in the library. When the search is complete, the HIS displays a list of the Topics satisfying the query, also shown in **Figure 3**. From that point, the reader can select one of the Topics for viewing. When the selected Topic's text is loaded, the search hits are highlighted, as shown in **Figure 4**. To see other search hits, the reader can scroll or use menu items.

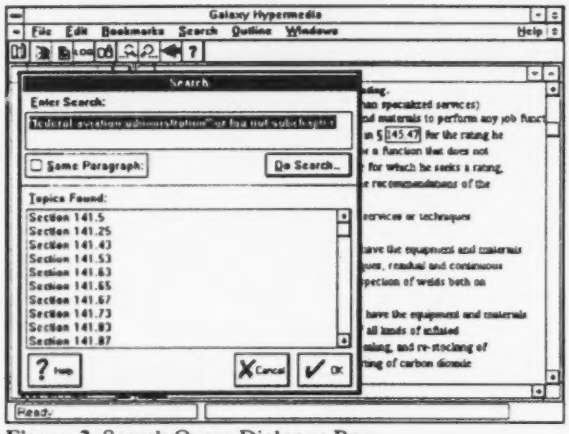

Figure 3 Search Query Dialogue Box

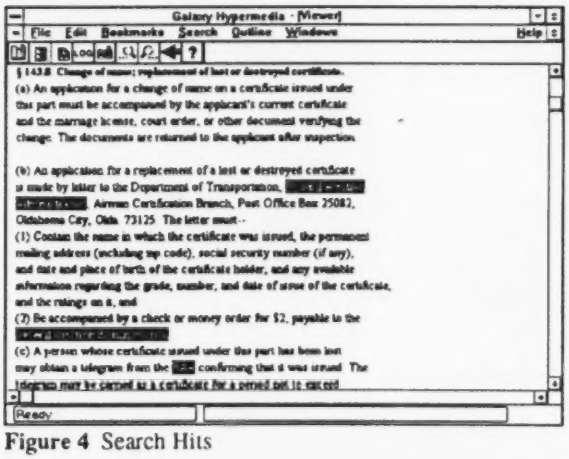

Figure 4 Search Hits

The HIS supports four types of searching: term, wildcard, phrase, and Boolean. The term search is the simplest. This is a search for one specific term, such as *aviation*, that is not a stopword. A stopword occurs so frequently in the document that it is not important; examples include *the* and *and*. Every Topic containing the search term is listed in the Search Query Dialogue Box.

The wildcard search allows the reader to look for variations of a term, i.e. *administrate*, *administration*, *administer*. A term or partial term can be appended with either an asterisk (*) or a question mark (?) wildcard. The asterisk represents zero or more characters, and the question mark represents zero characters or one character.

BEST COPY AVAILABLE

Phrase searching enables the reader to specify the order and adjacency of multiple search terms. For example, a phrase search for *"federal aviation administration"* will only display places where that exact phrase appears. The reader specifies a phrase search by placing quotes around the phrase to be searched.

Finally, the Boolean search combines any/all of the above types with Boolean operators (AND, OR, NOT), as in *"federal aviation administration" or faa not subchapter*. In this example, the search would return a list of all Topics containing either the phrase *federal aviation administration* or the term *faa*, but which do not contain the term *subchapter*.

Bookmarks. It is sometimes desirable for a reader to mark a place in a document. The HIS provides a bookmarking capability, enabling a reader to create multiple Bookmarks for a document. When creating a Bookmark, the HIS uses the Topic currently being viewed as the Bookmark's target destination. To use a previously created Bookmark, the reader chooses one from the list of active Bookmarks. The Topic containing the Bookmark does not have to be in the current library; the HIS will automatically switch libraries, if necessary.

Viewing

The HIS provides three distinct tools for accessing the various media comprising a hypermedia library. The Document Viewer has multiple entry mechanisms -- the Outline Viewer, the Search Query Dialogue Box, Bookmarks, and Hot Links. The Graphics Viewer and Multimedia Viewer are accessible only through Hot Links.

The Document Viewer. The Document Viewer, shown in **Figures 2** and **4**, allows a reader to scroll through and read a hypermedia document, as well as to investigate search hits. Text formatting such as boldface, italics, underlining, and multiple font size and face, enables the on-line document to closely resemble an original.

The Graphics Viewer. The Graphics Viewer appears when the reader clicks on a Hot Word linked to a static graphics image. It is used to view and print graphics. Supported graphics formats include, among others, bitmap (BMP), encapsulated postscript (EPS), target image file format (TIFF), and Joint Photographic Experts Group (JPEG). This is a seamless incorporation; the Graphics Viewer determines the format of the graphic and displays it appropriately.

The Multimedia Viewer. More innovative types of media are now available for computer presentation, e.g. sound, video, animation, etc. The Multimedia Viewer accommodates such media, determining the type of media when the reader selects a Hot Link to a media source and playing it appropriately. The HIS currently supports all MCI-supported media, including animation, video, cd-audio, and audio-video interleave.

Information Storage

Because a hypermedia document is more than just a digital version of a paper document, it is necessary to transform the original to a form that contains information for the HIS. This information runs the gamut from basic text formatting, such as which font to use, to links to other documents, graphics, animation, and other software programs. This transformation process (information storage shown in **Figure 5**) employs of a set of tools including editors, indexers, and database manipulators.

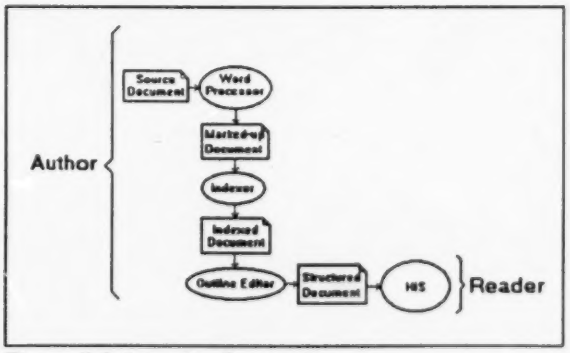

Figure 5 Information Storage Process

BEST COPY AVAILABLE

The first step in transforming a document is to create it or to open it in WordPerfect. This makes it possible to automatically take advantage of WordPerfect formatting such as boldface, italics, font, headers, etc. The author then adds Topic and Hot Link information to this document, using WordPerfect footnotes. The author also redlines any text which is to be designated a Hot Link in the viewer. This modified document is called a **Marked-up Document**. At this point, the marked-up document is ready to be indexed.

The Indexer is a two-pass tool. The first pass filters the WordPerfect document, translating it to ANSI text. The WordPerfect formatting information mentioned above is automatically translated into GML, a proprietary language developed by Galaxy, in the ANSI file. The footnote information the author added is also translated into GML. During the second pass, the Indexer parses the document and stores all information in a database. This is referred to as an **Indexed Document** in **Figure 5**. Each line of text is stored in the database, along with any GML formatting, Topic, and Hot Link information for that line. This makes document display and scrolling rapid and accurate. It also makes phrase searching precise. Each non-stopword in the document is also stored, along with its location in the document. This ensures quick, accurate term and wildcard searching. The database format is designed for optimal retrieval performance in large documents. A database storage mechanism increases speed in displaying a document, switching between documents, and searching. The database management system (DBMS) being used is Raima Corporation's Raima Data Manager which is compatible across PC, UNIX, Macintosh, and other platforms.

After a document is indexed, it must be structured. This step specifies the relative ordering, as well as hierarchical ordering, of all Topics the author defined in the WordPerfect document and results in the **Structured Document**. The author orders the Topics using the Outline Editor. The Outline Editor is similar to the Outline Viewer in the HIS reader interface; however, Topics are read-only in the Outline Viewer. In the Outline Editor, they are modifiable. Document structuring modifies the database. A collection of one or more structured documents forms a library to be viewed in the HIS.

HIS Applications

Now that the HIS has been described in detail, it is beneficial to how it has been used. As mentioned above, the driving force behind this project is the aviation industry. Aviation maintenance technicians, depending on their experience and maintenance role, estimate that as much as forty percent of their workday can be consumed with accessing technical information, usually spanning many volumes. Trying to locate all references to a particular component or procedure in such a large collection of data is daunting and time-consuming. It would require hours of effort, with no guarantee of locating all the references. Initial studies have found that the time spent searching a maintenance manual is reduced by as much as forty percent when the manual is on CD-ROM instead of paper or microfiche (Cruickshank, 1993). Improvements in the way aviation maintenance personnel access information will lead to more reliable and cost-effective aircraft maintenance. Toward this end, the HIS has been successfully integrated into multiple tutoring and job aiding systems for the FAA. These are described below.

The Environmental Control System (ECS) Tutor. This software (described in FAA/AAM & GSC, 1993) was sponsored by the FAA Office of Aviation Medicine as part of the HFAM research program. The ECS Tutor is an intelligent tutoring system which simulates the operation of the Air Conditioning portion of the ECS for the B-767-300.

Training manuals for the Boeing 767's ECS were indexed for access via the HIS. During a tutoring session, when a student requests information about ECS parts and procedures, it is displayed using the HIS. This allows direct access to information in a format familiar to the students using the tutor.

The Air Traffic Control Beacon Interrogator (ATCBI) Tutor. This software was sponsored by the FAA Technical Center, Advanced System Technology Branch (ACD-350) and is described in Jones and Jackson, 1992. This proof-of-concept tutor investigates the use of advanced technology for Airways Facilities maintenance training. The goal of the training system is to help experienced technicians maintain proficiency of their knowledge about the ATCBI-4.

This tutor contains a simulation of the ATCBI-4 and references information about the ATCBI-4. When requested by the student, information from the technical manual is brought up in the HIS. This information includes part/output descriptions, test/adjustment/replacement explanations, preventive maintenance procedures, standard and tolerance values, and functional block schematics.

The Performance Enhancement System. The Performance Enhancement System (PENS) (described in FAA/AAM & GSC, 1993) applies pen computer and hypermedia technology to provide real-time job aiding

and information retrieval for Aviation Safety Inspectors (ASIs) who must have access to large amounts of information. The Federal Aviation Regulations and the Airworthiness Inspector's Handbook have been indexed and put into a library for inspectors' use. As inspectors use PENS, they can directly access the HIS to reference and search for information. PENS is initially being distributed to ASIs in 9 U.S. locations for use and evaluation. Feedback will be provided regarding the HIS and will be used to make future enhancements.

Summary

The HIS has proven that hypermedia technology is useful to the aviation industry. For the HIS to continue to succeed, it must continue to evolve. The HIS must expand its document base and adhere to aviation documentation standards, such as Air Transport Association Specification 100 and Standard Generalized Markup Language (SGML). Also, because commercial and military aviation have many similarities, the HIS must also consider Department of Defense (DoD) standards. The DoD is mandated to use SGML by the Federal Computer-aided Acquisition and Logistical Support (CALS) program. Also, new weapons systems use Interactive Electronic Technical Manual (IETM) Specifications. The HIS will consider these and other emerging standards.

Additionally, in order to facilitate the creation of hypermedia documents, future work will improve the support tools for the author. The research will investigate ways to make the conversion from existing source documents to their hypermedia counterparts less time-consuming. This will include the development of filters for other word processing packages.

Advanced technology information systems such as the HIS will save the aviation industry time and money (Johnson, 1993). In addition, by providing a complete search of information, the HIS supports safer maintenance. While the HIS is only a part of safer, more cost-effective maintenance, it is an important part. Continued, enthusiastic cooperation from the aviation industry makes this possible.

Acknowledgements

This work has been supported by the Federal Aviation Administration Office of Aviation Medicine under contract DTFA01-92-Y-01005.

References

Cruickshank, D. (Spring 1993). Moving mountains at Boeing. *Iris Universe*, pp. 12-17.

Federal Aviation Administration, Office of Aviation Medicine (FAA/AAM) & Galaxy Scientific Corporation (GSC). (1993). *Human factors in aviation maintenance - Phase three, volume one progress report.* (NTIS No. DOT/FAA/AM-93/15).

Federal Aviation Administration, Office of Aviation Medicine (FAA/AAM) & Galaxy Scientific Corporation (GSC). (1994). *Human factors in aviation maintenance - Phase three, volume two progress report.*

Johnson, W. B. (1993). Human factors research: Can it have an impact on a financially troubled aviation industry? *Proceedings of the 37th Annual Meeting of the Human Factors and Ergonomics Society.* Seattle, WA: The Human Factors and Ergonomics Society.

Johnson, W. B. & Norton, J. E. (1992). Integrated information for maintenance training, aiding, and on-line documentation. *Proceedings 36th Annual Meeting of the Human Factors Society.* Atlanta, GA: The Human Factors Society.

Jones, J. A. & Jackson, J. (1992). Proficiency training systems for airway facilities technicians. *Proceedings 7th Annual Meeting on Human Factors Issues in Aircraft Maintenance and Inspection.* Atlanta, GA.

[1]*Reader* refers to someone using the HIS to view documents.

[2]*Author* refers to someone who puts a document or collection of documents into a hypermedia library for use by the HIS.